#### **APPENDIX A**

#### CALIFORNIA SALMONID STREAM RESTORATION HABITAT MANUAL



STATE OF CALIFORNIA RESOURCES AGENCY
DEPARTMENT OF FISH AND GAME
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#### HABITAT TYPING

The habitat typing procedure presented is a standardized methodology that physically describes 100 percent of the wetted channel. It is a composite of systems principally developed or modified by other investigators and compiled in part by Trinity Fisheries Consulting on contract to DFG.

Habitat types are described according to location, orientation, and water flow. The attributes distinguishing the various habitat types include over-all channel gradient, velocity, depth, substrate, and the channel features responsible for the unit's formation.

A basin-level habitat inventory is designed to produce a thorough description of the physical fish habitat. Basin-level habitat classification is on the scale of a stream's naturally occurring pool-riffle-run units. The length of a habitat unit depends on stream size and order. For basin-level habitat inventory, homogeneous areas of habitat that are equal or greater in length than one wetted channel width are recognized as distinct habitat units. During basin-level habitat typing, full sampling of each habitat unit requires recording all characteristics of each habitat unit as per the "Instructions for completing the Habitat Inventory Data Form" (Part III). After DFG analysis of over 200 stream habitat inventory data sets, it was determined that similar stream descriptive detail could be accomplished with a sampling level of approximately 10 percent (Appendix O).

The information provided by habitat and channel typing, and biological information collected during spawning surveys and/or juvenile rearing surveys aids in determining if critical habitat needs of a target species are lacking, and if there are areas where improvements can be made.

There are four levels of classification used to describe physical fish habitat. Each higher level in the sequence includes more descriptive categories of habitat types (Figure III-8). Level I categorizes habitat into riffles or pools. Level II categorizes riffles into riffle or flatwater habitat types, for a total of three types (riffle, pool, and flatwater). Level III further differentiates riffle types on the basis of water surface gradient (riffle or cascade), and pool types according to their location in the stream channel (main channel, lateral scour, or backwater). At Level IV, pools are categorized by the cause of formation (obstruction, blockage, constriction, or merging flows); riffles are categorized by gradient; and cascades by gradient and substrate type; and flatwaters are categorized by depth and velocity. Level IV habitat types are the 24 habitat types listed on page III-30 and diagramed on pages III-31 through III-42.

Prior to conducting an inventory, the level of data collection necessary to meet the needs of the investigation should be established. Habitat typing at Level IV will provide the greatest detail and the most complete description of existing habitat. This data can later be aggregated into broader levels of habitat classification if detail is found to be excessive.

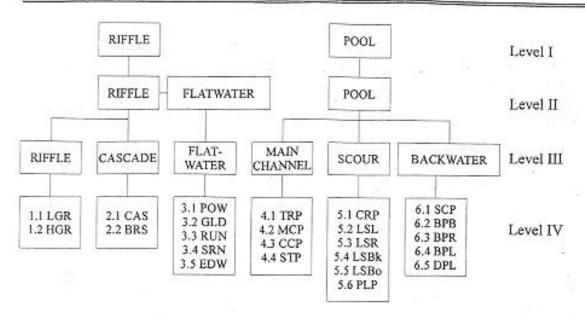


Figure III-8. Habitat types hierarchy.

Generally a stream will not contain all 24 habitat types. The mix of habitat types will be reflective of the overall channel gradient, flow regime, cross-sectional profile, and substrate particle size. Basins that exhibit a wide range in channel gradient will also have a broad mix of habitat types. Stratifying a basin by channel types helps to predict the location of certain habitat types.

Project-level habitat typing is used to evaluate and quantify changes in habitat as the result of fish habitat restoration/enhancement projects. It will provide insight on the relationship between channel features and habitat development. For project-level habitat typing, the minimum size of a habitat unit is equal to the width of the wetted stream channel. For a more detailed habitat analysis, the units can be reduced. The habitat unit size used depends on the nature and objective of the particular study. Regardless of unit size, Level IV habitat types should be used.

Habitat typing is intended to yield detailed information that can be used for fisheries management. Basin-wide habitat typing can provide a variety of data. Some important applications are:

- Physically describe 100 percent of the habitat in a basin.
- Provide baseline data to evaluate habitat responses to restoration efforts.
- Facilitate restoration planning and fisheries management.
- Determine transect locations for Instream Flow Incremental Methodology (IFIM) modeling based on habitat availability and accessibility.

#### Definition of Habitat Types

The following list of habitat types and their hierarchy has been adapted from the original system developed by Bisson, et al. (1982), modified by Decker, Overton, et al. (1985), and Sullivan (1988).

#### Level I Habitat Types:

RIFFLE:

(Riffle, Cascade, Flatwater)

POOL:

(Main Channel Pool, Scour Pool, Backwater Pool)

#### Level II Habitat Types:

RIFFLE:

(Low-Gradient Riffle, High-Gradient Riffle, Cascade, Bedrock Sheet)

FLATWATER:

(Pocket Water, Run, Step Run, Glide, Edgewater)

POOL:

(Plunge Pool, Mid-Channel Pool, Dammed Pool, Step Pool, Channel Confluence Pool, Trench Pool, Lateral Scour Pool - Root Wad Enhanced, Boulder Formed, Bedrock Formed, and Log Enhanced, Corner Pool, Secondary Channel Pool, Backwater Pool -Boulder Formed, Root Wad Formed, and Log Formed)

#### Level III and Level IV Habitat Types:

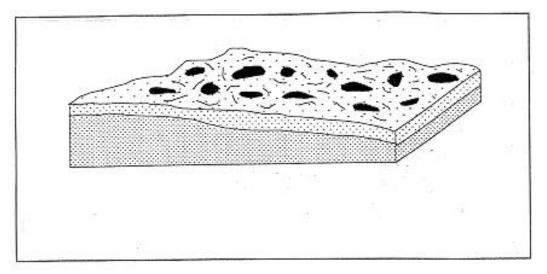
The three or four letter abbreviations in parentheses, (\*\*\*), are the standardized abbreviations adopted by DFG. The three digit numbers in brackets, [\*.\*], are the standardized numbers adopted by DFG. The numbers in braces, {\*\*}, are the numbers listed in the Pacific Southwest Region Habitat Typing Field Guide, USDA-USFS. Table on next page.

LEVEL III and LEVI	EL IV HABITA	T TYPES	
Low Gradient Riffle	(I CD)		2012000
High Gradient Riffle	(LGR) (HGR)	[1.1]	{ 1}
angii Gradicii Kime	(HOK)	[1.2]	{ 2}
CASCADE			
Cascade	(CAS)	[2.1]	{ 3}
Bedrock Sheet	(BRS)	[2.2]	{24}
FLATWATER			
Pocket Water	(POW)	[3.1]	{21}
Glide	(GLD)	[3.2]	{14}
Run	(RUN)	[3.3]	{15}
Step Run	(SRN)	[3.4]	{16}
Edgewater	(EDW)	[3.5]	{18}
MAIN CHANNEL POOL			
Trench Pool	(TRP)	[4.1]	(8)
Mid-Channel Pool	(MCP)	[4.2]	{17}
Channel Confluence Pool	(CCP)	[4.3]	{19}
Step Pool	(STP)	[4.4]	{23}
SCOUR POOL			
Corner Pool	(CRP)	[5.1]	{22}
L. Scour Pool - Log Enhanced	(LSL)	[5.2]	{10}
L. Scour Pool - Root Wad Enhanced	(LSR)	[5.3]	{11}
L. Scour Pool - Bedrock Formed	(LSBk)	[5.4]	{12}
L. Scour Pool - Boulder Formed	(LSBo)	[5.5]	{20}
Plunge Pool	(PLP)	[5.6]	{ 9}
BACKWATER POOLS			
Secondary Channel Pool	(SCP)	[6.1]	{ 4}
Backwater Pool - Boulder Formed	(BPB)	[6.2]	{ 5}
Backwater Pool - Root Wad Formed	(BPR)	[6.3]	{ 6}
Backwater Pool - Log Formed	(BPL)	[6.4]	{ 7}
Dammed Pool	(DPL)	[6.5]	{13}
ADDITIONAL UNIT DESIGNATIONS			
Dry	(DRY)	[7.0]	
Culvert	(CUL)	[8.0]	
Not Surveyed	(NS)	[9.0]	
Not Surveyed due to a marsh	(MAR)	[9.1]	

### Level IV Habitat Type Descriptions:

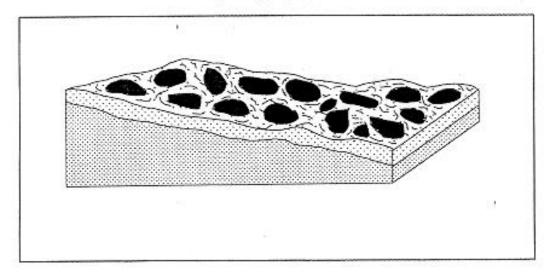
The following habitat type descriptions are taken from the Pacific Southwest Region Habitat Typing Field Guide, USDA-USFS.

# LOW-GRADIENT RIFFLE (LGR) [1.1] {1}



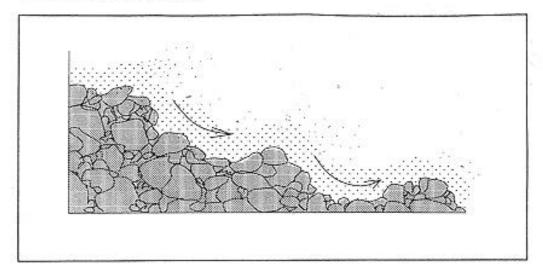
Shallow reaches with swiftly flowing, turbulent water with some partially exposed substrate. Gradient < 4%, substrate is usually cobble dominated.

### HIGH-GRADIENT RIFFLE (HGR) [1.2] {2}



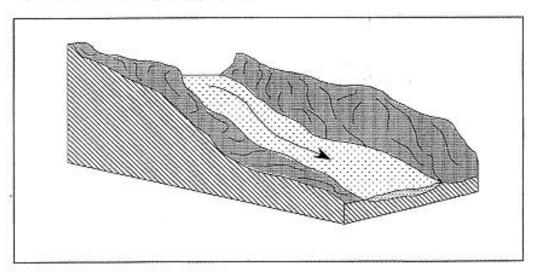
Steep reaches of moderately deep, swift, and very turbulent water. Amount of exposed substrate is relatively high. Gradient is > 4%, and substrate is boulder dominated.

## CASCADE (CAS) [2.1] {3}



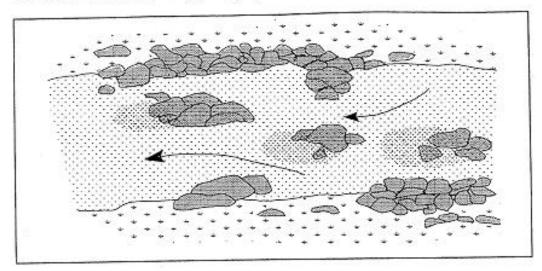
The steepest riffle habitat, consisting of alternating small waterfalls and shallow pools. Substrate is usually bedrock and boulders.

### BEDROCK SHEET (BRS) [2.2] {24}



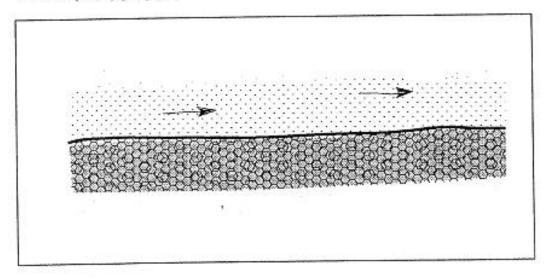
A thin sheet of water flowing over a smooth bedrock surface. Gradients are highly variable.

# POCKET WATER (POW) [3.1] {21}



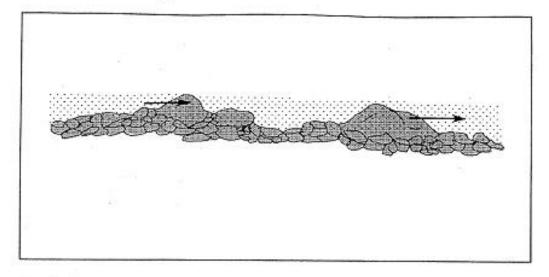
A section of swift-flowing stream containing numerous boulders or other large obstructions which create eddies or scour holes (pockets) behind the obstructions.

## GLIDE (GLD) [3.2] {14}



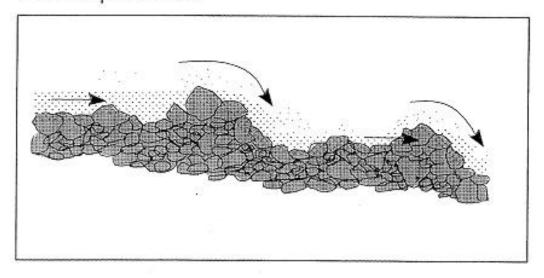
A wide, uniform channel bottom. Flow with low to moderate velocities, lacking pronounced turbulence. Substrate usually consists of cobble, gravel, and sand.

# RUN (RUN) [3.3] {15}



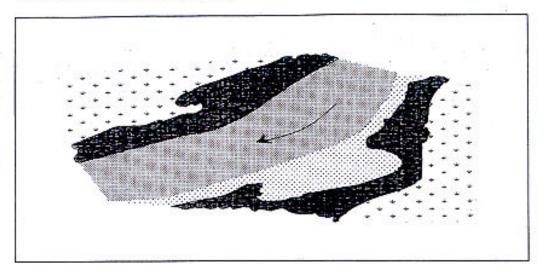
Swiftly flowing reaches with little surface agitation and no major flow obstructions. Often appears as flooded riffles. Typical substrate consists of gravel, cobble, and boulders.

#### STEP RUN (SRN) [3.4] {16}



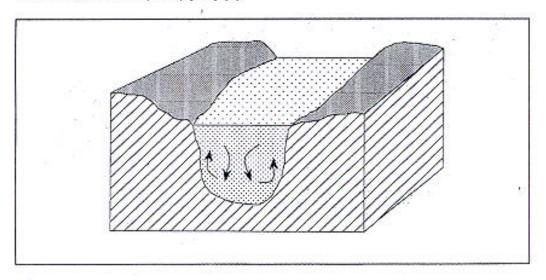
A sequence of runs separated by short riffle steps. Substrate is usually cobble and boulder dominated.

#### EDGEWATER (EDW) [3.5] {18}



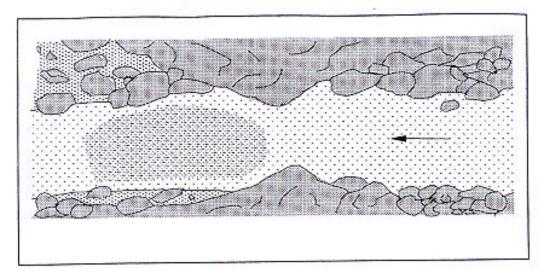
Quiet, shallow area found along the margins of the stream, typically associated with riffles. Water velocity is low and sometimes lacking. Substrate varies from cobbles to boulders.

#### TRENCH POOLS (TRP) [4.1] {8}



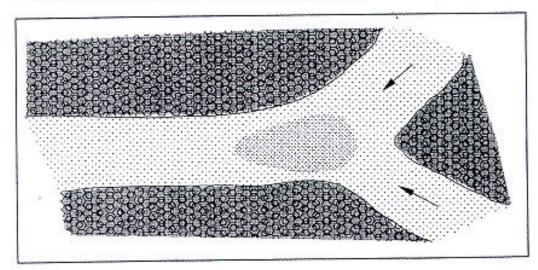
Channel cross sections typically U-shaped with bedrock or coarse grained bottom flanked by bedrock walls. Current velocities are swift and the direction of flow is uniform.

#### MID-CHANNEL POOL (MCP) [4.2] {17}



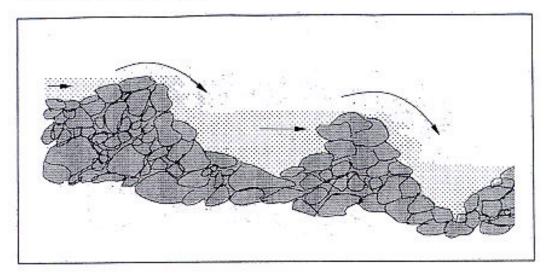
Large pools formed by mid-channel scour. The scour hole encompasses more than 60% of the wetted channel. Water velocity is slow, and the substrate is highly variable.

# CHANNEL CONFLUENCE POOL (CCP) [4.3] {19}



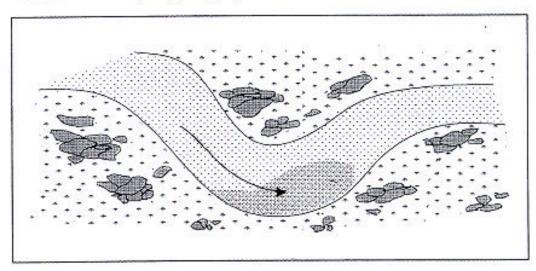
Large pools formed at the confluence of two or more channels. Scour can be due to plunges, lateral obstructions or scour at the channel intersections. Velocity and turbulence are usually greater than those in other pool types.

## STEP POOL (STP) [4.4] {23}



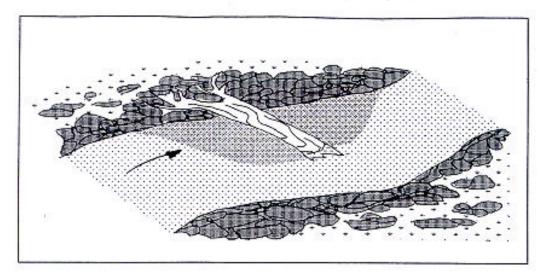
A series of pools separated by short riffles or cascades. Generally found in highgradient, confined mountain streams dominated by boulder substrate.

# CORNER POOL (CRP) [5.1] {22}



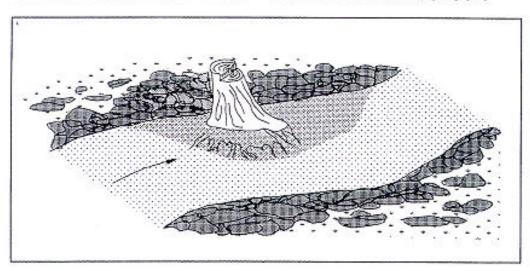
Lateral scour pools formed at a bend in the channel. These pools are common in lowland valley bottoms where stream banks consist of alluvium and lack hard obstructions.

# LATERAL SCOUR POOL - LOG ENHANCED (LSL) [5.2] {10}



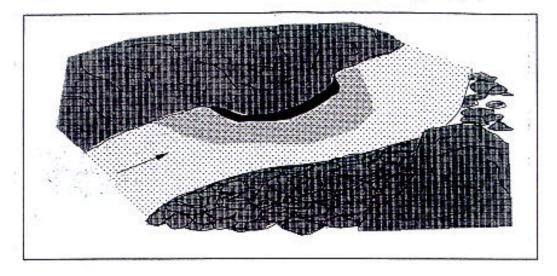
Formed by flow impinging against a partial channel obstruction consisting of large woody debris. The associated scour is generally confined to < 60% of the wetted channel width.

# LATERAL SCOUR POOL - ROOT WAD ENHANCED (LSR) [5.3] {11}



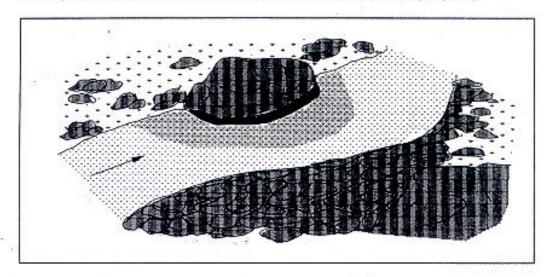
Formed by flow impinging against a partial channel obstruction consisting of a root wad. The associated scour is generally confined to < 60% of the wetted channel width.

### LATERAL SCOUR POOL - BEDROCK FORMED (LSBk) [5.4] {12}



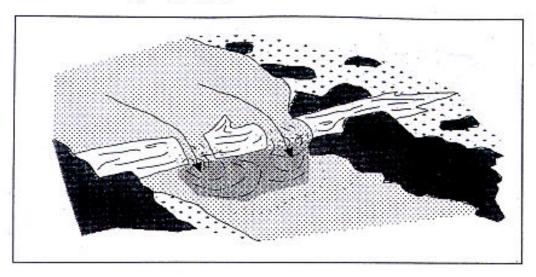
Formed by flow impinging against a bedrock stream bank. The associated scour is generally confined to < 60% of the wetted channel width.

#### LATERAL SCOUR POOL - BOULDER FORMED (LSBo) [5.5] {20}



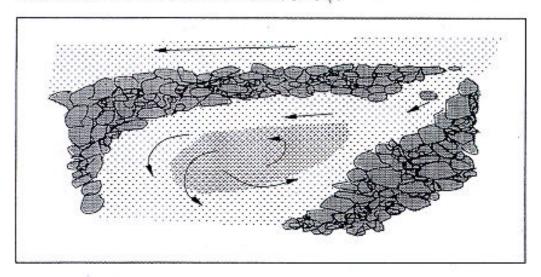
Formed by flow impinging against a partial channel obstruction consisting of a boulder. The associated scour is generally confined to < 60% of the wetted channel width.

# PLUNGE POOL (PLP) [5.6] {9}



Found where the stream passes over a complete or nearly complete channel obstruction and drops steeply into the streambed below, scouring out a depression; often large and deep. Substrate size is highly variable.

### SECONDARY CHANNEL POOL (SCP) [6.1] {4}



Pools formed outside of the average wetted channel width. During summer, these pools will dry up or have very little flow. Mainly associated with gravel bars and may contain sand and silt substrate.